

<b>REPORT DOCUMENTATION PAGE</b>				<i>Form Approved</i> <i>OMB No. 0704-0188</i>	
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<b>4. TITLE AND SUBTITLE</b>  PRL S-030A Verification Survey at Former McClellan AFB, Sacramento, CA				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b>	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Maj Alan Hale				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> USAF School of Aerospace Medicine Occupational and Environmental Health Dept/OEC 2510 Fifth St. Wright-Patterson AFB, OH 45433-7913				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFRL-SA-WP-CL-2013-0005	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSORING/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
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<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine Consultative Services Division (USAFSAM/OEC) completed an independent radiological assessment/verification survey from 23-25 Oct 12 at site PRL S-030A on former McClellan AFB, CA. This verification survey was conducted at the site after the contractor had completed the majority of the excavation of contaminated soils from the site. Radium-226 was the sole radionuclide of concern. Cabrera Services, Inc., under contract with Tetra Tech, conducted all radiological field work to include the Final Status Survey (FSS). This letter details the findings of this visit and is meant to assist the RICS when evaluating the contractor's FSS report of this site.					
<b>15. SUBJECT TERMS</b> USAF School of Aerospace Medicine (USAFSAM), former McClellan AFB, radium-226, verification survey, final status survey, independent radiological assessment					
<b>16. SECURITY CLASSIFICATION OF:</b>			<b>17. LIMITATION OF ABSTRACT</b>	<b>18. NUMBER OF PAGES</b>	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b> U	<b>b. ABSTRACT</b> U	<b>c. THIS PAGE</b> U			Col Mark Smallwood
			SAR	27	<b>19b. TELEPHONE NUMBER (include area code)</b>



**DEPARTMENT OF THE AIR FORCE**  
**AIR FORCE RESEARCH LABORATORY**  
**WRIGHT-PATTERSON AFB OHIO**

25 March 2013

**MEMORANDUM FOR AFMSA/SG3PB**

**ATTN: MAJ DANIEL SHAW**  
**USAF RADIOISOTOPE COMMITTEE SECRETARIAT**  
**AIR FORCE MEDICAL SUPPORT AGENCY**  
**7700 ARLINGTON BOULEVARD, SUITE 5158**  
**FALLS CHURCH, VA 22042-5158**

**FROM: USAFSAM/OEC**  
**2510 Fifth Street**  
**Wright-Patterson AFB, OH 45433**

**SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0005, PRL S-030A Verification**  
**Survey at Former McClellan AFB, Sacramento, CA**

**1. INTRODUCTION:**

a. *Purpose:* At the request of the U.S. Air Force Radioisotope Committee Secretariat (RICS), the U.S. Air Force School of Aerospace Medicine Consultative Services Division (USAFSAM/OEC) completed an independent radiological assessment/verification survey from 23-25 Oct 2012 at site PRL S-030A on former McClellan AFB, CA. This verification survey was conducted at the site after the contractor had completed the majority of the excavation of contaminated soils from the site. Radium-226 (Ra-226) was the sole radionuclide of concern. Cabrera Services, Inc., under contract with Tetra Tech, conducted all radiological field work including the Final Status Survey (FSS). This letter details the findings of this visit and is meant to assist the RICS when evaluating the contractor's FSS report of this site.

b. *Survey Personnel:*

- (1) Chief, Radiation Health Consulting Branch, USAFSAM/OEC
- (2) Health Physics Technician, USAFSAM/OEC

c. *Personnel Contacted:*

- (1) Radiation Program Manager, AFCEC/CIBW
- (2) Radiation Safety Officer, AFCEC/CIBW

d. *Equipment:*

- (1) Ludlum-Model 2221, serial number 218606, calibrated on 23 Nov 11
- (2) Ludlum-Model 44-10, serial number PR276614, calibrated on 23 Nov 11
- (3) Ludlum-Model 2221, serial number 78153, calibrated on 25 Nov 11
- (4) Ludlum-Model 44-10, serial number PR276615, calibrated on 25 Nov 11

## 2. METHODOLOGY:

a. *Background Area*: The background area of 400 m<sup>2</sup> has been routinely used as a reference area since it was determined to be radiologically nonimpacted. The background area was characterized with the 2x2 sodium iodide detector using a gamma walkover technique. No soil samples were taken in the background area, as the background soil concentrations for former McClellan AFB were determined previously and were not relevant for this survey. After gamma walkover surveys at the survey sites, it was determined that the background area was not consistent with the survey areas, most likely due to the fact the background area still had vegetation in place. The background data are, therefore, irrelevant and are not presented.

b. *Survey Areas*: Cabrera Services, Inc. was responsible for conducting a total of two FSSs at two different sites. The week of the visit, PRL S-030A was anticipated to be available for USAFSAM verification. Therefore, after consultation with the RICS, it was chosen for this survey. During the week of the visit, PRL S-030A had not been completely remediated. The eastern portion of the site had residual contamination that the contractors were still surveying and remediating; therefore, the FSS of the site had not been completed. As a result, USAFSAM was only able to survey the area of PRL S-030A that had been remediated. The survey area underwent gamma walkover surveys and soil sampling. This verification survey required at least 10% of the survey area to be scanned by the gamma walkover technique and soil sampling totaling at least 10% of the number taken by the contractor. Further information on the surveys can be found in Attachments 1-2.

(1) *Gamma Walkover Survey in Survey Area*: The goals of the walkover survey were to detail site radiological conditions, identify potential spots of elevated residual Ra-226 concentrations, and identify locations for biased soil sampling. Since the gamma walkover data were to qualitatively assess the site in terms of mean reading plus amount of standard deviation (SD), minimum detectable concentration and count rates were not calculated. Table 1, in section 3, summarizes the results of the gamma walkover survey.

(2) *Soil Sampling in Survey Area*: Since the contractor planned to collect 64 soil samples at PRL S-030A, 8 biased soil samples were collected based on walkover data exhibiting elevated count rates. Each sample was taken from an area of about 8 square inches to a depth of 6 inches. The volume sampled was enough for laboratory analysis (approximately 0.25 gallon). Field soil sampling procedures were in place to prevent cross-contamination of samples. Table 2, in section 3, summarizes the soil sample results.

3. RESULTS: The results are summarized below along with some basic discussion. Additional substantiating data, including maps and survey data, can be found in Attachments 1-5.

**Table 1. Gamma Walkover Results Summary**

Instrument	Mean Count Rate (cpm)	SD (cpm)	No. of Readings > Mean + 3 SD
Ludlum Model 2221/44-10 (SN: 218606/PR276614)	7313	931	14
Ludlum Model 2221/44-10 (SN: 78153/PR276615)	7282	828	84

Table 2. Soil Sampling Results Summary

Sample No.	Ra-226 Concentration (pCi/g)	Ra-226 Concentration Uncertainty (pCi/g)
CS00001	17.2	±0.248
CS00002	1.09	±0.0613
CS00003	1.30	±0.0525
CS00004	7.44	±0.149
CS00005	1.99	±0.0672
CS00006	1.83	±0.0588
CS00007	0.831	±0.0489
CS00008	1.51	±0.0571

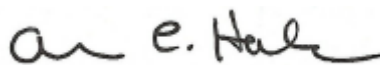
#### 4. CONCLUSIONS:

a. All soil samples were taken in biased locations where elevated Ra-226 concentrations were expected to be found. The maximum Ra-226 concentration was  $17.2 \pm 0.248$  pCi/g. This area was identified during the survey as needing remediation; see Figure A2-3 in Attachment 2. Additionally two other samples, CS00004 and CS00005, were greater than the cleanup goal of 2.0 pCi/g when uncertainty is added.

b. USAFSAM acknowledges that the site had not undergone a comprehensive contractor FSS when the portion of the site was verified by USAFSAM. However, the contractor failed to identify the areas USAFSAM detected during its remediation support surveys.

c. Based upon the findings of this verification survey, USAFSAM recommends the RICS carefully review the contractor's FSS report for PRL S-030A before the site is approved for unrestricted free release of radiological controls.

5. If you have any questions or need further information, please contact Maj Alan Hale at 937-938-3320 (DSN 798-3320) or alan.hale@us.af.mil.



ALAN C. HALE, Maj, USAF, BSC  
Chief, Radiation Health Consulting Branch

#### 5 Attachments:

1. Instrumentation and Survey Methodology
2. Survey of PRL S-030A
3. Laboratory Soil Analysis
4. Instrument Calibration Sheets
5. Radiation Meter QC Log

## ATTACHMENT 1

### INSTRUMENTATION AND SURVEY METHODOLOGY

1. *Sodium Iodide Detector:* The sodium iodide detectors used were Ludlum 44-10 2x2-inch detectors coupled with a Ludlum 2221 ratemeter/scaler. For walkover surveys, the Ludlum 2221 was connected via cable to a Trimble GeoXT handheld GPS unit. The Trimble GeoXT logged the count rates with the corresponding GPS coordinates every second. The detector was held at 10 cm above the ground for soil readings and walkover surveys. During walkovers, the scan speed was approximately 0.5 meters per second. This is consistent with the contractor methodology used during gamma walkover surveys.
2. *Laboratory Analysis of Soil:* Soil samples were counted at the USAFSAM Radioanalytical Laboratory (OEAL) at WPAFB, OH. The soil was counted on a high purity germanium detector. The soils were also analyzed by OEAL using the appropriate in-growth method to determine Ra-226 levels in soil. Attachment 3 contains the laboratory reports.
3. All field instruments were function checked and field tested before and after use with a check source. All instruments were tested to ensure a 20% tolerance during field checks. All of the instruments passed the tolerance function check except the post-survey check of survey meter serial number 218606 with probe serial number PR276614 as documented in Attachment 5. A review of the data collected with this meter verified that the data were valid. The suspected reason for the instrument failing the post-survey check was a loose connection in the probe. While surveying, the probe was held vertically, which did not affect the connection; however, during the function check the probe was in a horizontal position, which affected the connection. All instruments are calibrated on an annual basis at WPAFB, OH. Attachment 4 contains all annual calibration sheets and Attachment 5 is the Radiation Meter QC Log.

## ATTACHMENT 2

### SURVEY OF PRL S-030A

1. *Location:* Figures A2-1, A2-2, and A2-3 are photographs of the PRL S-030A site during verification survey work. Note standing water in the excavation area (Figures A2-1 and A2-2), which limited the area available for the gamma walkover survey.



**Figure A2-1. Photograph of PRL S-030A, Gamma Walkover Survey**





**Figure A2-2. Photograph of PRL S-030A, Soil Sampling**



**Figure A2-3. Photograph of PRL S-030A, Hotspot Found Corresponding to Soil Sample CS0001**

2. *Survey Results:* Eight soil samples were taken at the PRL S-030A site. The gross Ra-226 soil concentration results are in Table A2-1, which is inclusive of the background Ra-226 concentration and can be compared directly to the cleanup goal of 2.0 pCi/g. The locations of the soil samples are in Figure A2-4. The PRL S-030A site area of approximately 5000 m<sup>2</sup> was characterized with a sodium iodide detector using a gamma walkover technique. Scan coverage was approximately 75%. Due to the shallow nature of the excavation, only the floor of the excavation was scanned and not the side walls. The resultant data of this walkover are listed in Figure A2-5. Since there was a disparity in the mean count rates of the background survey area and the survey unit due to soil difference, through analysis of the statistics the mean count rate of the survey unit itself and associated statistics were used as the “background” for this survey unit. The lowest readings of the survey are marked in green and correspond to less than 2 SDs above the mean background value. This green area is where soil concentrations are expected to be the lowest. The other colors represent areas of statistical significance where higher concentrations are expected to be found. Yellow and red colors correspond to greater than 2 and 3 SDs, respectively, above the mean count rate value. The color scheme demonstrates a scale of instrument data based upon SDs from background, where no regulatory values are implied.



Table A2-1. Soil Sample Results for PRL S-030A

Sample No.	GPS Coordinates (°N/°E)	Gross Ra-226 Concentration (pCi/g)
CS00001	38.650007/ -121.406722	17.2 ± 0.248
CS00002	38.650110/ -121.406746	1.09 ± 0.0613
CS00003	38.649986/ -121.406863	1.30 ± 0.0525
CS00004	38.649945/ -121.406921	7.44 ± 0.149
CS00005	38.649909/ -121.406917	1.99 ± 0.0672
CS00006	38.649484/ -121.406786	1.83 ± 0.0588
CS00007	38.649473/ -121.406710	0.831 ± 0.0489
CS00008	38.649502/ -121.407166	1.51 ± 0.0571

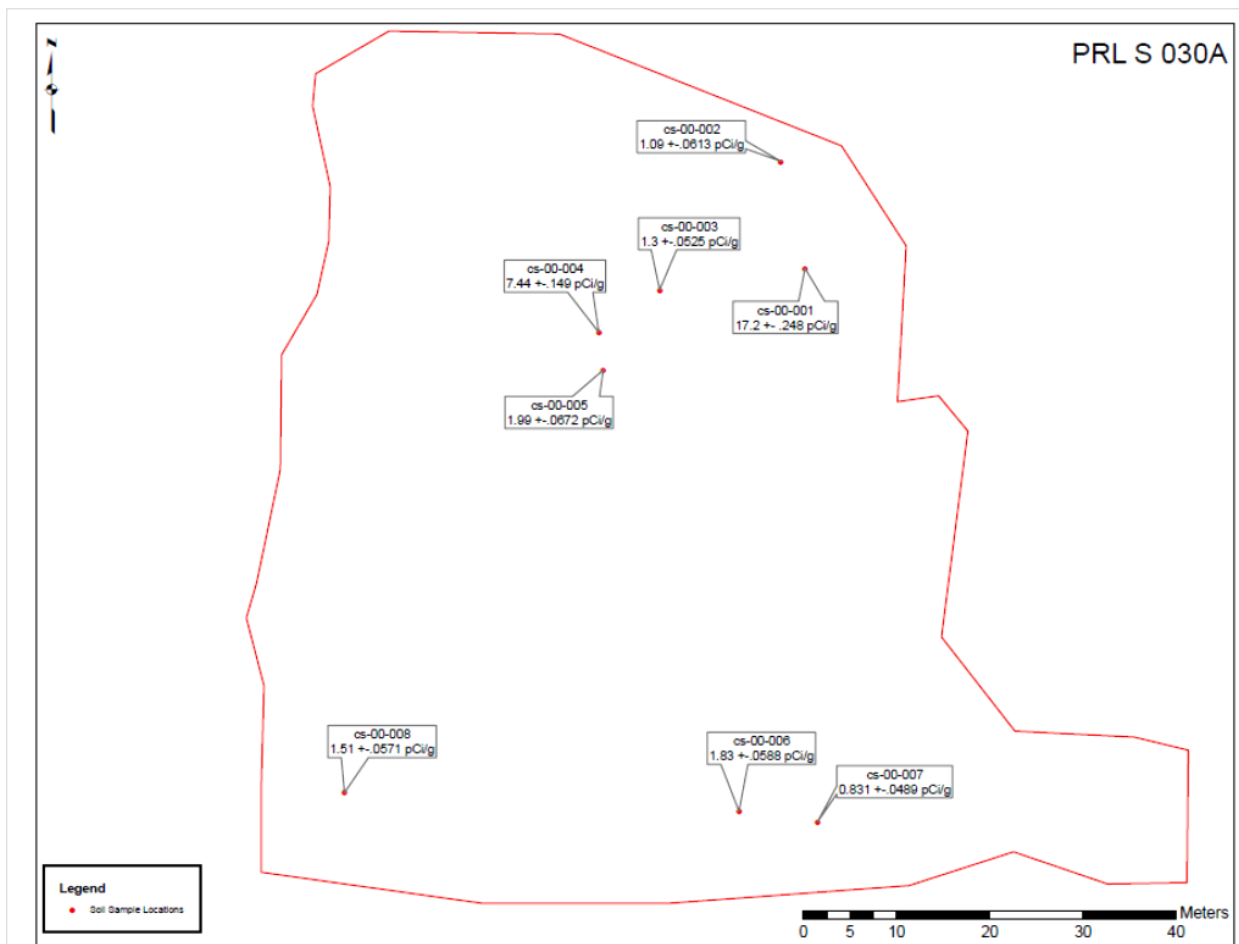


Figure A2-4. Soil Sample Locations for PRL S-030A



**Figure A2-5. Gamma Walkover Data for PRL S-030A**

## ATTACHMENT 3

### LABORATORY SOIL ANALYSIS

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#### Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200280

Customer Address 01172

77 MDOS/SGPB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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#### IDENTIFICATION

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Base Sample # CS00001

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes	Activity +/- Uncertainty	Lc / MDA
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RADIUM 226	1.72E+01 +/- 2.48E-01 pc/g	7.71E-02 / 1.57E-01 pc/g
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#### COMMENTS

RA226

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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If you have any questions concerning the information provided above, please  
contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch

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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OEHHL ID 11200281

Customer Address 01172

77 MDOS/SGPB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

---

IDENTIFICATION

---

Base Sample # CS00002

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes

Activity +/- Uncertainty

Lc / MDA

RADIUM 226

1.09E+00 +/- 6.13E-02 pcig

5.63E-02 / 1.15E-01 pcig

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

---

If you have any questions concerning the information provided above, please  
contact the ESOH Service Center at 1-888-232-2383.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch



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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200282

Customer Address 0117Z

77 MDOS/SGFB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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IDENTIFICATION

---

Base Sample # CS00003

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes

Activity +/- Uncertainty

Lc / MDA

RADIUM 226

1.30E+00 +/- 5.25E-02 pcig

4.43E-02 / 9.07E-02 pcig

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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If you have any questions concerning the information provided above, please  
contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, ESO  
Chief, Analytical Laboratory Branch

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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200283

Customer Address 01172

77 MDOS/SGFB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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IDENTIFICATION

---

Base Sample # CS00004

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes

Activity +/- Uncertainty

Lc / MDA

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RADIUM 226

7.44E+00 +/- 1.49E-01 pci/g

6.11E-02 / 1.25E-01 pci/g

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch

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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200284

Customer Address 01172

77 MDOS/SGPB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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IDENTIFICATION

---

Base Sample # CS00005

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes

Activity +/- Uncertainty

Lc / MDA

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RADIUM 226

1.99E+00 +/- 6.72E-02 pd/g

4.31E-02 / 8.87E-02 pd/g

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch

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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200285

Customer Address 01172

77 MDOS/SGPB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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IDENTIFICATION

---

Base Sample # CS00006

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes

Activity +/- Uncertainty

Lc / MDA

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RADIUM 226

1.83E+00 +/- 5.88E-02 pci/g

4.46E-02 / 9.18E-02 pci/g

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch



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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200286

Customer Address 01172

77 MDOS/SGPB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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IDENTIFICATION

---

Base Sample # CS00007

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

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Analytes

Activity +/- Uncertainty

Lc / MDA

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RADIUM 226

8.31E-01 +/- 4.89E-02 pci/g

4.11E-02 / 8.47E-02 pci/g

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch

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Sample Analysis Results Reported on 07-Jan-2013

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USAFSAM/OMHHL ID 11200287

Customer Address 01172

77 MDOS/SGPB

5342 DUDLEY BLVD

MCCLELLAN AFB

CA 95652-1074

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IDENTIFICATION

---

Base Sample # CS00008

Serial #

Date Collected 10/25/2012

Received 10/29/2012

Completed 12/20/2012

---

Analytes

Activity +/- Uncertainty

Lc / MDA

RADIUM 226

1.51E+00 +/- 5.71E-02 pci/g

3.86E-02 / 7.92E-02 pci/g

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COMMENTS

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RESULTS ACCURATE TO 2 SIGNIFICANT FIGURES.  
UNCERTAINTY AT 95% CONFIDENCY LEVEL.

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contact the ESOH Service Center at 1-888-232-2353.

ROBERT D. SCHMIDTGOESSLING, Major, USAF, BSC  
Chief, Analytical Laboratory Branch

## ATTACHMENT 4

## INSTRUMENT CALIBRATION SHEETS

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DEPARTMENT OF THE AIR FORCE  
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)  
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)  
WRIGHT-PATTERSON AFB OHIO  
**CERTIFICATE OF CALIBRATION**

Mfg. Ludlum Model 2221 Serial # 218606 Index # 049333 Date 23 Nov 11  
Mfg. Ludlum Model 94-10 Serial # PR276614 Index # 100861 Cal. Due Date: 23 Nov 12

## TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments			
Isotope	Serial #	Cal. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs-137	RP3067	1 Nov 04	2,454,000	Ludlum	500-1	102951	8 Feb 2012

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☒ Battery Ck. ☒ Mechanical Ck. ☒ Meter Zeroed ☒ Reset Ck. ☐ Alarm Ck.  
☒ Audio Ck. ☒ Geotopism Ck. ☒ F/S Resp. Ck. ☒ Window Cp.

As Found HV 991 VDC Temperature 72.7 °F Relative Humidity 55 %

Final Volt. Set 100 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V  
Inst. Readout: 500 V  $\pm$  2% Inst. Readout: 1000 V  $\pm$  2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	400,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	200 CPM	200 CPM

## DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	39,886 CPM	39,886 CPM

\*UNCERTAINTY WITHIN  $\pm$  10% CORRECTION FACTOR WITHIN  $\pm$  20%

COMMENTS: Calibration Interval = 1 year Use "Window Out"  
Cs-137 Eff: 6,500 CPM/ $\mu$ ci/ $m^2$  @ 12"

Procedural Authority - ICP#22210000

Calibrated By: STU Hutchinson  
Reviewed By: Piper Miller

Date: 23 Nov 2011  
Date: 30 Nov 11

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**DEPARTMENT OF THE AIR FORCE  
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)  
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)  
WRIGHT-PATTERSON AFB OHIO  
CERTIFICATE OF CALIBRATION**

Meter: \_\_\_\_\_ Date: 23 Nov 11  
Mfg. Ludlum Model 2221 Serial # 218606 Index # 099333 Cal. Due Date: 23 Nov 12

**TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT**

**NIST Traceable Check Sources**

**Reference Instruments**

Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs-137	RP3067	1 Nov 04	2,454,000	Ludlum	500-1	102951	8 Feb 2012

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

**NaI DETECTOR HIGH VOLTAGE OPTIMIZATION**

Probe #1  
Mfg. Ludlum  
Model 44-10  
Serial # PR276614  
Index # 100861  
Isotope: Cs-137

Probe #2  
Mfg. \_\_\_\_\_  
Model \_\_\_\_\_  
Serial # \_\_\_\_\_  
Index # \_\_\_\_\_  
Isotope: \_\_\_\_\_

Probe #3  
Mfg. \_\_\_\_\_  
Model \_\_\_\_\_  
Serial # \_\_\_\_\_  
Index # \_\_\_\_\_  
Isotope: \_\_\_\_\_

High Voltage	CPM
750	7834
800	9969
850	11523
900	12240
950	12771
1000	12851
1050	13589
1100	13500
1150	13697
1200	13684
1250	13908
1300	13966
1350	17910
Bkgd @ 1100	4664

High Voltage	CPM

High Voltage	CPM

Final Volt. Set 1100 VDC      Final Volt. Set \_\_\_\_\_ VDC      Final Volt. Set \_\_\_\_\_ VDC  
Efficiency 6500 CPM/μCi/m<sup>2</sup> @ 12"      Efficiency \_\_\_\_\_ CPM/μCi/m<sup>2</sup> @ 12"      Efficiency \_\_\_\_\_ % 2π @ 12"

COMMENTS: Calibration Interval = 1 year      Use "Window LCR"

Calibrated By: Stu Hutchinson      Date: 23 Nov 2011  
Reviewed By: K. N. V. L.      Date: 30 Nov 11



Page 3 of 4

HotSpot FIDLER Text File Output:  
HotSpot FIDLER Calibration Information

Report Date : Nov 23 2011 07:07 AM  
Calibration Date : 23 Nov, 2011  
Target Mix : Other Nuclide Check Source  
Radionuclide : Cs-137  
Detector Barcode Number : 100861  
Meter Barcode Number : 099333  
Detector Manufacturer : Ludlum  
Detector Model Number : 44-10  
Detector Serial Number : PR276614  
Meter Manufacturer : Ludlum  
Meter Model Number : 2221  
Meter Serial Number : 218606

Check Source I.D. : RP 3067  
Calibration Date : 23 Nov, 2011  
Calibrated by : Stu Hutchinson  
Check Source Activity (uCi) : 1.100E+00  
Check Source 17-keV Self : 1.000E+00

Sample Counting Time (minutes) : 1.000E+00  
Detector Height (cm) : 3.000E+01

Cs-137 Window Information:

Background (cpm) : 4,669  
Areal Limit of Sensitivity (uCi/m2) : 4.9E-02  
Point Limit of Sensitivity (uCi) : 1.0E-01  
K-factor (m2) : 2.07

Counting Data (counts):

0-cm: 8120  
20-cm: 7179  
40-cm: 6081  
60-cm: 5469  
80-cm: 5167  
100-cm: 5069

Instrument Type : Other  
Window Option: Only 60 keV  
Units: Classic

This is an actual 2 x2 calibration and the values are typical of most 2 x2 configurations.

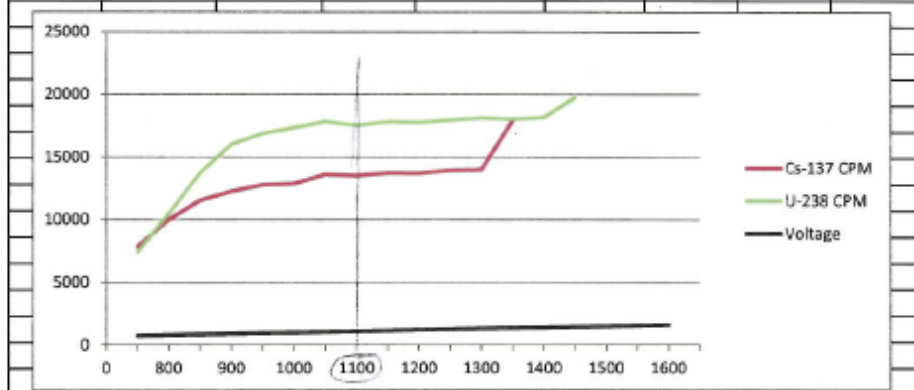
Detector Calibration Results

Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)): 6.5E+03  
Cs-137 Detector Areal LOS (uCi/m2) : 4.9E-02  
Cs-137 Detector Point LOS (uCi) : 1.0E-01  
Cs-137 Detector Background Rate (cpm) : 4,669  
Cs-137 Detector Check Source Rate (cpm) : 3,451  
Cs-137 Detector K-Factor (m2) : 2.07  
Cs-137 Detector K-Factor sdev (%) : 7.5

Cs-137 Eff: 6,500 CPM/uCi/m2 @ 12"

VDC	Cs-137 CPM	DU Slug		Ludlum 2221	SN 218606			
				Ludlum 44-10	SN 276614			
750	7834	7417						
800	9969	10456						
850	11523	13713						
900	12240	16030						
950	12771	16869						
1000	12851	17336						
1050	13589	17835						
1100	13500	17515						
1150	13697	17816						
1200	13684	17764						
1250	13908	17946						
1300	13966	18133						
1350	17910	18023						
1400		18159						
1450		19730						
1500								
1550								
1600								





DEPARTMENT OF THE AIR FORCE  
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)  
OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)  
WRIGHT-PATTERSON AFB OHIO  
**CERTIFICATE OF CALIBRATION**

Mfg. Ludlum Model 2221 Serial # 78153 Index # 04125 Date: 25 Nov 11  
Mfg. Ludlum Model 44-10 Serial # 28276615 Index # 100862 Cal. Due Date: 25 Nov 12

## TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments		
Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Cal. Due Date
Cs-137	RP3067	1 Nov 04	2,454,000	Ludlum	500-1	102951
						8 Feb 2012

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

☒ Battery Ck. ☒ Mechanical Ck. ☒ Meter Zeroed ☒ Reset Ck. ☐ Alarm Ck.  
☒ Audio Ck. ☒ Geotroism Ck. ☒ F/S Resp. Ck. ☒ Window Op.

As Found HV 703 VDC Temperature 73.1 °F Relative Humidity 54.6 %

Final Volt. Set 1250 VDC Threshold (LLD) 10 mV Window (ULD) 20 mV Window width 10 mV

HV Readout (2 points) Reference: 500 V Reference: 1000 V  
Inst. Readout: 499 V ± 2% Inst. Readout: 1000 V ± 2%

RANGE MULTIPLIER	REFERENCE CAL. POINT	"AS FOUND" READING	CORRECTED READING
x 1000	400 CPM	400,000 CPM	400,000 CPM
x 1000	100 CPM	100,000 CPM	100,000 CPM
x 100	400 CPM	40,000 CPM	40,000 CPM
x 100	100 CPM	10,000 CPM	10,000 CPM
x 10	400 CPM	4,000 CPM	4,000 CPM
x 10	100 CPM	1,000 CPM	1,000 CPM
x 1	400 CPM	400 CPM	400 CPM
x 1	100 CPM	100 CPM	100 CPM
Log Scale	200 CPM	199 CPM	199 CPM

## DIGITAL SCALER READOUT

CAL. REF. POINT	AS FOUND READING	CORRECTED READING
40,000 CPM	39,889 CPM	39,889 CPM

\*UNCERTAINTY WITHIN ± 10% CORRECTION FACTOR WITHIN ± 20%

COMMENTS: Calibration Interval = 1 year Use "Window Dot"  
Cs-137 Eff. 2,900 CPM/μCi/m<sup>2</sup> @ 12"  
DU-238 response curve determined. Procedural Authority - ICP#22210000

Calibrated By: Steve Hutchinson

Date: 25 Nov 2011

Reviewed By: Ripmiller

Date: 30 Nov 11



DEPARTMENT OF THE AIR FORCE  
 USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)  
 OCCUPATIONAL ENVIRONMENTAL HEALTH/RADIATION HEALTH (OEHH)  
 WRIGHT-PATTERSON AFB OHIO  
**CERTIFICATE OF CALIBRATION**

Meter Mfg. Ludlum Model 2221 Serial # 78153 Index # 04125 Cal. Due Date: 25 Nov 11  
 Date: 25 Nov 12

## TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT

NIST Traceable Check Sources				Reference Instruments			
Isotope	Serial #	Cert. Date	DPM	Mfg.	Model	Serial #	Cal. Due Date
Cs-137	RP3067	1 Nov 04	2,454,000	Ludlum	500-1	102951	8 Feb 2012

Measurement Standards and test equipment used are traceable to the National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facilities.

## NaI DETECTOR HIGH VOLTAGE OPTIMIZATION

Probe #1  
 Mfg. Ludlum  
 Model 44-10  
 Serial # PR276615  
 Index # 100862  
 Isotope: Cs-137

High Voltage	CPM
900	11393
950	12953
1000	13581
1050	14078
1100	14215
1150	15057
1200	15173
1250	15017
1300	15267
1350	15501
1400	15212
1450	15503
Bkgd @ 1250	4532

Final Volt. Set 1250 VDC

Efficiency 2960 CPM/ $\mu\text{Ci m}^2 @ 12"$

Probe #2  
 Mfg. Ludlum  
 Model 44-10  
 Serial # PR276615  
 Index # 100862  
 Isotope: DU-slug

High Voltage	CPM
900	10618
950	13590
1000	16229
1050	17132
1100	17581
1150	17881
1200	18157
1250	18419
1300	18455
1350	18452
1400	18499
1450	
Bkgd @ 1250	

Final Volt. Set 1250 VDC

Efficiency NA CPM/ $\mu\text{Ci m}^2 @ 12"$

Probe #3  
 Mfg. \_\_\_\_\_  
 Model \_\_\_\_\_  
 Serial # \_\_\_\_\_  
 Index # \_\_\_\_\_  
 Isotope: \_\_\_\_\_

High Voltage	CPM
900	
950	
1000	
1050	
1100	
1150	
1200	
1250	
1300	
1350	
1400	
1450	
Bkgd @ 1250	

Final Volt. Set \_\_\_\_\_ VDC

Efficiency \_\_\_\_\_ %  $2\pi @ 1/4"$

COMMENTS: Calibration Interval = 1 year Use "Window But"  
DU-238 response curve determined.

Calibrated By: Stu Hutchinson

Date: 25 Nov 2011

Reviewed By: Pam Mills

Date: 30 Nov 11



HotSpot FIDLER Text File Output  
 HotSpot FIDLER Calibration Information

Report Date : Nov 23 2011 11:12 AM  
 Calibration Date : 23 Nov, 2011  
 Target Mix : Other Nuclide Check Source  
 Radionuclide : Cs-137  
 Detector Barcode Number : 100862  
 Meter Barcode Number : 04125  
 Detector Manufacturer : Ludlum  
 Detector Model Number : 44-10  
 Detector Serial Number : PR276615  
 Meter Manufacturer : Ludlum  
 Meter Model Number : 2221  
 Meter Serial Number : 78153

Check Source I.D. : RP 3067  
 Calibration Date : 23 Nov, 2011  
 Calibrated by : Stu Hutchinson  
 Check Source Activity (uCi): 1.100E+00  
 Check Source 17-keV Self : 1.000E+00

Sample Counting Time (minutes) : 1.000E+00  
 Detector Height (cm) : 3.000E+01

Cs-137 Window Information:  
 Background (cpm) : 4,532  
 Areal Limit of Sensitivity (uCi/m2) : 1.1E-01  
 Point Limit of Sensitivity (uCi) : 9.3E-02  
 K-factor (m2) : 0.84

Counting Data (counts):

0-cm: 8279  
 20-cm: 7135  
 40-cm: 6023  
 60-cm: 5398  
 80-cm: 5067  
 100-cm: 4747

Instrument Type : Other  
 Window Option: Only 60 keV  
 Units: Classic

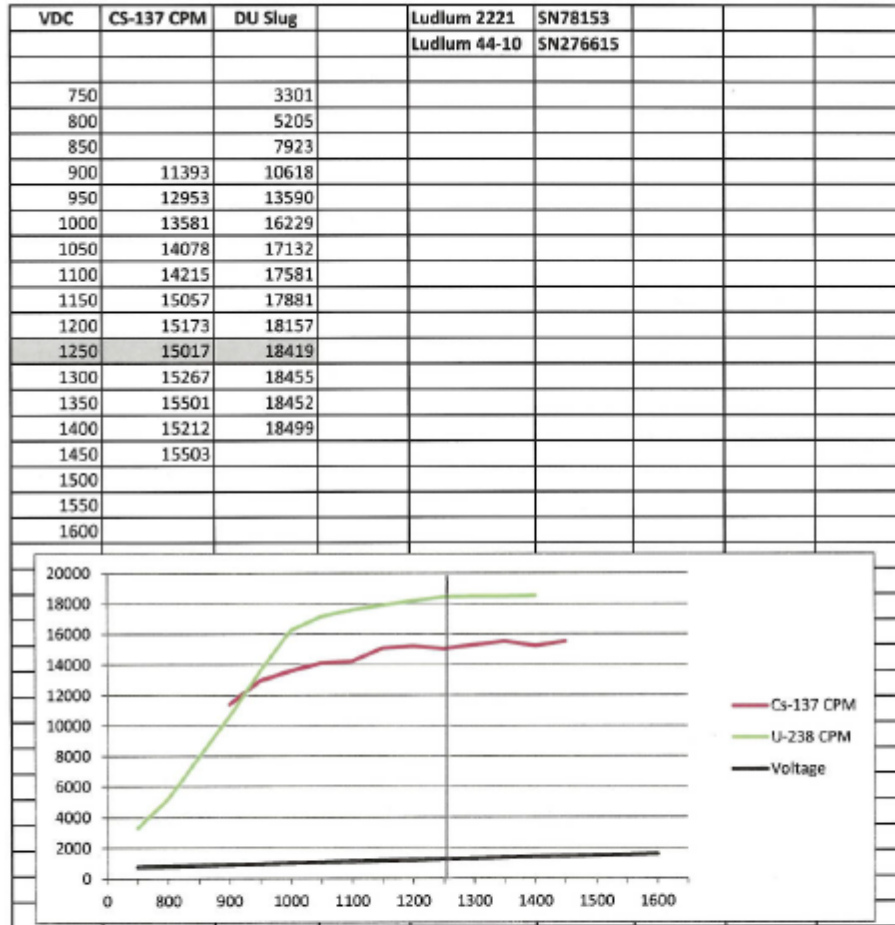
This is an actual 2 x 2 calibration and the values are typical of most 2 x 2 configurations.

Detector Calibration Results

Cs-137 Window Information:

Cs-137 Detector Efficiency (cpm/(uCi/m2)): 2.9E+03  
 Cs-137 Detector Areal LOS (uCi/m2) : 1.1E-01  
 Cs-137 Detector Point LOS (uCi) : 9.3E-02  
 Cs-137 Detector Background Rate (cpm) : 4,532  
 Cs-137 Detector Check Source Rate (cpm) : 3,747  
 Cs-137 Detector K-Factor (m2) : 0.84  
 Cs-137 Detector K-Factor sdev (%) : 7.4

Cs-137 Eff: 2900 CPM/uCi/m<sup>2</sup> @ 12"



# ATTACHMENT 5

## RADIATION METER QC LOG

Radiation Meter QC Log

Model	S/N	Date/Time	HV/cables/Bat check	Source Check Reading	Acceptable Range
2221 3x2	78153 PR276615	22oct12/1800	✓	21772 cpm	17418 - 26126 cpm
2221 2x2	218606 PR276614	22oct12/1500	✓	20476 cpm	16381 - 24571 cpm
2221 2x2	78153 PR276615	23oct12/1400	✓	20283 cpm	17418 - 26126 cpm
2221 2x2	218606 PR276614	23oct12/1400	✓	19821 cpm	16381 - 24571 cpm
2221 2x2	78153 PR276615	23oct12/1446	✓	19839 cpm	17418 - 26126 cpm
2221 2x2	218606 PR276614	23oct12/1447	✓	19210 cpm	16381 - 24571 cpm
2221 2x2	78153 PR276615	24oct12/1300	✓	22047 cpm	17418 - 26126 cpm
2221 2x2	218606 PR276614	24oct12/1300	✓	19763 cpm	16381 - 24571 cpm
2221 2x2	78153 PR276615	24oct12/1529	✓	21346 cpm	17418 - 26126 cpm
2221 2x2	218606 PR276614	24oct12/1532	✓	656 cpm	16381 - 24571 cpm
2221 2x2	78153 PR276615	25OCT12/1300	✓	19572 cpm	17418 - 26126 cpm
2221 2x2	78153 PR276615	25OCT12/1433	✓	21413 cpm	17418 - 26126 cpm

★ The post check did not meet acceptable range. It affects the crystal connection to PMT or diodes are bad. Data collected with this meter will be closely evaluated to see if is usable.